

PROCESS FOR THE PREPARATION OF FUEL GAS WITH REDUCED CALORIFIC VALUE

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1390643 Fuel gas SHELL INTERNA- TIONALE RESEARCH MAATSCHAPPIJ NV 28 April 1972 [30 April 1971] 19878/72 Heading C5E A fuel gas of reduced e.v. is made from lique- fied petroleum gas or natural gas by combusting a minor, branch, stream of the gas and cooling it by vaporizing water in direct contact with the combustion gas, to form an inert gas of regula- table temperature, and mixing the inert gas with the other, major, stream of the original gas. The amount of gas branched off is automatically controlled in response to temperature variations in the final gas stream, and the amount of water delivered to the branch stream is likewise automatically controlled by the temperature of the inert gas.

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PATENT SPECIFICATION

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(54) PROCESS FOR THE PREPARATION OF FUEL GAS WITH REDUCED CALORIFIC VALUE

(71) We, SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ N.V., a company organised under the laws of The Netherlands, of 30 Carel van Bylandtlaan, The Hague, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a process for the preparation, from a fuel of high calorific value, of fuel gas with reduced calorific value, the fuel of high calorific value being a liquefied petroleum gas or a gaseous fuel.

The use of liquefied petroleum gas as an industrial fuel normally requires its conversion from the liquid into the gaseous phase. Various types of vaporizers are known in which the required heat of vaporization is supplied, for example, by electric heating or by means of gas-heated recuperators.

In many cases, however, the gas obtained, such as butane or propane, is unsuitable as a fuel gas, because it has too high a calorific value. It must be reduced to a calorific value which is suitable for the use envisaged, and although this value may vary between certain limits, it is far lower than the calorific value of the original gas.

This reduction can be effected by the admixture therewith of air or of an inert gas in the form of a combustion gas. For the heating of shaft furnaces, for example, a fuel gas of approx. 9,000 Kcal/Nm³ is employed, which, if butane is used to form a fuel gas, requires the prior admixture therewith of approx. 70% by volume of air or inert gas, based on the fuel gas. An apparatus has also been proposed (UK patent specification 1,158,934) in which the heat of vaporization for a liquefied petroleum gas is obtained by burning a

minor part (a branch stream) of the liquefied petroleum gas to form a combustion gas which is used to vaporise the remainder of the liquefied petroleum gas (the main stream) by direct heating.

If natural gas is used instead of liquefied petroleum gas for the intended purposes, the first process step, i.e. vaporization, is omitted, but the second, i.e. the reduction of its calorific value, remains necessary. When switching over from liquefied petroleum gas to natural gas, only the vaporizer may be circumvented, but not the mixing apparatus.

In many cases, therefore, the preparation of fuel gas from liquefied petroleum gas in the conventional manner requires two process steps which increase the cost and difficulty by using liquefied petroleum gas. If the one-step process according to UK patent specification 1,158,934 is followed, there is the risk, when the hot combustion gases meet the remaining liquefied petroleum gas, of cracking reactions with inconvenient coke or soot deposits. To reduce this risk to acceptable proportions, the temperature in the mixer unit should be kept as low as possible and consequently the gas stream from the burner unit should be kept as small as possible consistent with the need to ensure the complete vaporization of the remaining liquefied petroleum gas. The reduction in calorific value resulting from the dilution of the vaporised liquefied petroleum gas with the combustion gas is insufficient for many purposes; moreover, it is uncontrollable. Also, there is the risk that the gas stream leaving the mixer unit may be too hot for the equipment to which it is supplied.

According to the present invention a process for the preparation of a fuel gas comprises combusting a minor amount of a liquefied petroleum gas or of a gaseous fuel, mixing the resulting combustion gas

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with water whereby said gas is cooled by the vaporisation of the water and an inert gas containing the cooled gas in admixture with water vapour is formed, and mixing the inert gas with a major amount of said liquefied petroleum gas or gaseous fuel.

The liquefied petroleum gas or the gaseous fuel which is combusted in the process of the present invention is conveniently referred to as a branch stream, and the liquefied petroleum gas or the gaseous fuel with which said inert gas is mixed to form the desired fuel gas is conveniently referred to as a main stream.

Also, according to the present invention, apparatus for carrying out the process just defined, comprises a burner unit comprising a pressure nozzle burner, a blower for combustion air and a combustion controller, an injection vaporiser disposed downstream of the burner unit, and an injection mixer for mixing inert gas from the injection vaporiser with liquefied petroleum gas or gaseous fuel.

The burner unit of the apparatus according to the invention is immediately followed by cooling means comprising an injection vaporiser in which the gas from the burner unit is cooled by vaporization of water. The vaporization is effected by direct heating, suitably by spraying the water in the gas stream; the water vapour remains in the gas. The amount of water can be controlled in accordance with the inert gas temperature, i.e. the temperature of the inert gas leaving the injection vaporiser, which is required, preferably, the temperature of the inert gas leaving the injection vaporiser does not exceed 600°C in order to avoid any soot deposits in the following injection mixer.

The amount of said liquefied petroleum gas or of said gaseous fuel combusted is preferably controlled in accordance with the required temperature of the fuel gas and the amount of liquefied petroleum gas or gaseous fuel with which said inert gas is mixed to form said fuel gas.

In the injection mixer the inert gas vaporises the main stream of the liquefied petroleum gas or mixes with the gaseous fuel as the case may be. In the former case the liquefied petroleum gas is vaporised by direct heating, suitably by spraying in the inert gas stream. The resulting gas mixture leaving the injection mixer is a fuel gas of lower calorific value ready for use.

By the process of the invention it is possible to prepare fuel gases with differing colorific values from the same basic fuel, for example, liquefied butane. If the branch stream of liquefied petroleum gas to the burner unit is set as low as possible, i.e. the gas and/or inert gas volumes are

kept small and at the same time the quantity of water to the cooling unit is kept so low, i.e. the inert gas temperature is set so high, that soot formation in the mixer unit is only just avoided, a fuel gas of very high calorific value is obtained. The limit is substantially determined by the dewpoint of the fuel gas which, the smaller the ratio between branch stream and main stream becomes, the colder it leaves the mixer unit. In this mode of operation the apparatus operates substantially as a conventional vaporizer. If, on the other hand, the branch stream to the burner unit is increased, fuel gases with higher proportions of inert gas and lower calorific values are obtained. Accordingly, the quantity of water to the cooler unit is also suitably increased, i.e. the inert gas temperature is set lower, under certain conditions still below the recommended value of 600°C. The proportion of inert gas is thereby increased further and at the same time an undesirably high temperature of the fuel gas is avoided. In this manner it is possible to produce fuel gases with any desired low calorific value, which then of course have a relatively high proportion of water vapour and therefore a high dewpoint. For all practical purposes, however, the limits imposed by the dewpoint on the range of control play no role at low calorific values.

The process remains unchanged if instead of liquefied petroleum gas a high-calorific value gaseous fuel such as natural gas is used. In this case the mixer unit operates as a simple mixing chamber, as a rule without conversion being necessary. Of course, in this mode of operation a relatively higher temperature is obtained in the fuel gas, for which reason the temperature of the inert gas is suitably set so low as is permissible with regard to the dewpoint of the fuel gas.

Apparatus in accordance with the invention may be constructed from items of equipment which individually are known per se. The burner unit used may suitably be one of the known burners for the direct combustion of liquified petroleum gas, for example, a pressure nozzle burner. The combustion air is supplied by a blower and is controlled in proportion to the liquefied petroleum gas branch stream. The CO₂ concentration and/or the CO + H₂ concentration of the combustion gas is advantageously monitored and the results used, in a known manner, as an additional aid for controlling the amount of combustion aid supplied.

The cooling unit suitably consists of an injection vaporizer of suitable size, if necessary fitted with pump and filter for the water supply. The quantity of water is controlled by a temperature sensitive device

which is arranged in the inert gas stream downstream of the injection vaporizer.

An injection vaporizer of a kind known per se is likewise suitably used for the mixer unit.

The quantity of the branch stream of liquefied petroleum gas to the burner unit is controlled in proportion to the quantity of the main stream to the mixer unit. A temperature sensitive device is suitably arranged downstream of the mixer unit and the temperature of the fuel gas used as an additional aid for controlling the amount of liquefied petroleum gas combusted. If the temperature falls below a predetermined value, which is certainly above the dew-point determined by the fuel gas composition the ratio between branch stream and main stream is increased, i.e. the branch stream to the burner unit is increased. Under operating conditions in which the temperature of the fuel gas is in the vicinity of its dewpoint, there is a certain variation in the calorific value of the fuel gas. For almost all practical purposes, however, this is insignificant and at any rate far less inconvenient than condensate formation in the fuel gas line and in its associated equipment.

As a safeguard, a further control system is suitably arranged, which actuates a shut-off valve in the branch stream upstream of the burner unit and in the main stream upstream of the mixer unit and is triggered by a flow controller in the water stream upstream of the cooling unit. Advantageously, this at the combustion point or a flow controller in the air stream to the combustion point, so that if there is a breakdown in the offtake of fuel gas, the entire apparatus is automatically shut down.

The accompanying drawing shows a flow and control scheme representing a preferred embodiment of the present invention, and in which liquefied petroleum gas is used as basic fuel.

The liquefied petroleum gas enters at 1. A branch stream flows to the burner unit, via a control valve 2 to a burner 3. The burning unit further comprises a blower 4 for the combustion air, which is controlled by a combustion control device 5 by means of a control valve 6. The control device 5 is actuated in accordance with signals received from a flowmeter device 7 and from a CO₂ measuring point 8, which is arranged in the gas stream from the burner 3.

The gas from the burner unit flows to an injection vaporizer 9 of the cooling unit. It is supplied with water via a line 10 and a control valve 11. An associated control device 12 is activated in accordance with signals received from a temperature

measuring point 14, which is arranged in the gas stream downstream of the injection vaporizer 9.

The inert gas from the cooling unit flows to an injection mixer 15 of the mixer unit. The main stream of liquefied petroleum gas is admitted via a main control valve 16. Downstream of the injection mixer 15 the fuel gas stream passes an adjustable pressure control valve 17, by means of which the apparatus can be operated under super-atmospheric pressure; in that case, a safety valve 18 is of course also required.

The control valve 2 in the branch stream of liquefied petroleum gas is actuated by a mixing controller 19, which is actuated in accordance with signals received from a flowmeter device 20 in the main stream and from a temperature measuring point 21 in the fuel gas stream. Operating safety is ensured by a control device 22, which actuates magnetic cut-off valves 23 and 24 in the main stream and branch stream of the liquefied petroleum gas and which is triggered on the one hand by a flow controller 25 and on the other by a flame controller or flow controller connected with the combustion point (not shown).

WHAT WE CLAIM IS:

1. A process for the preparation of a fuel gas comprising combusting a minor amount of a liquefied petroleum gas or of a gaseous fuel, mixing the resulting combustion gas with water whereby said gas is cooled by the vaporisation of the water and an inert gas containing the cooled gas in admixture with water vapour is formed, and mixing the inert gas with a major amount of said liquefied petroleum gas or gaseous fuel.

2. A process as claimed in claim 1, wherein the amount of said liquefied petroleum gas or of said gaseous fuel combusted is controlled in accordance with the required temperature of the fuel gas and the amount of liquefied petroleum gas or gaseous fuel with which said inert gas is mixed to form said fuel gas.

3. A process as claimed in claim 1, wherein the amount of water is controlled in accordance with the inert gas temperature required.

4. A process for the preparation of a fuel gas as claimed in claim 1 and substantially as hereinbefore described.

5. An apparatus suitable for carrying out the process claimed in claim 1, which comprises a burner unit comprising a pressure nozzle burner, a blower for combustion air and a combustion controller, an injection vaporiser disposed downstream of the burner unit, and an injection mixer for mixing inert gas from the injection vaporiser

with liquefied petroleum gas or gaseous fuel.

6. Apparatus as claimed in claim 5 and substantially as hereinbefore described with particular reference to the accompanying drawing.

7. A fuel gas prepared by the process claimed in any one of claims 1-4.

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COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of
the Original on a reduced scale.*

